

Modern Concepts of Cardiovascular Disease

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THE HEART AND DEFICIENCY DISEASES

Deficiency diseases are commonly thought of as those due to avitaminosis. In considering the relationship of deficiency diseases to the evolution of heart lesions and abnormal cardiac physiology, it is profitable to be more inclusive and to consider the effect of a deficiency of any of the elements concerned in the maintenance of normal heart muscle physiology.

Deficiency in the elements of food essential to health may occur from:

- a. An absolute lack of supply
- b. An inability of the organism to absorb the material ingested
- c. An abnormal wastage of ingested material
- d. An inability to synthesize the absorbed elements

When the characteristic symptoms of a deficiency disease exist, it must be appreciated that the deficiency has probably existed for a prolonged time for there are protective reserves of essential elements which must be exhausted before symptoms appear, and the rapidity of the depletion of the reserves is influenced by such diverse factors as infections, physical exercise, sunshine, metabolic diseases, and the total caloric value of the ingested food.

In judging the importance of food deficiencies as related to the heart two questions are immediately presented for consideration. These are:

- A. Is the heart so affected in avitaminosis that its functional integrity is impaired to the degree that heart failure ensues?
- B. Is the functional efficiency of the diseased heart liable to premature failure, or is the heart which is failing under strain made functionally less efficient by the development of nutritional deficiencies in the myocardium resulting from disturbance of heart muscle metabolism?

A. *Avitaminosis*: Beriberi, a disease which is primarily the result of a deficiency of water soluble vitamin B₁ is characterized by peripheral neuritis, edema, and in many cases cardiac insufficiency.

From the view point of heart disease beriberi occupies a unique position in clinical medicine for it emphasizes the importance of dietary deficiencies in the production of serious degrees of myocardial failure. Patients dying of beriberi show definite changes in the heart. There exist varying degrees

of dilatation of the chambers, particularly the right ventricle and auricle. Histologically there is a hydropic degeneration of the muscle fibers with fatty infiltration of the myocardium. Because of the frequent occurrence in beriberi of neuritis, and nutritional edema, as well as congestive heart failure the patients are divisible into three groups: (1) neuritic type; (2) edematous type; (3) cardiac type. While these types invariably overlap, the cardiac type is seen in those patients in whom neuritis is present only in a mild form.

The onset of beriberi is insidious, and progressive. Fatiguability and palpitation on exertion occur early. Breathlessness is felt, but is not so pronounced as the above symptoms. In the well developed case of the cardiac type of beriberi, the symptoms are those of congestive heart failure. The heart shows varying degrees of enlargement, and the character of the apex beat is feeble and diffuse indicating a preponderance of cardiac dilatation. Systolic murmurs are frequent but diastolic murmurs are not present. The pulmonic second sound is accentuated, but pulmonary congestion is infrequently present. There may be marked venous engorgement and an enlarged tender liver in the more advanced degrees of heart failure.

The heart rate is as a rule accelerated above 100 beats per minute and the rate is easily accelerated by the slightest exertion. The blood pressure is not characteristically altered. Edema of the lower extremities occurs early and in advanced untreated cases general edema with ascites and hydrothorax occurs. The electrocardiograms are characterized by a notable absence of disturbances of cardiac rhythm, but frequently show small complexes, depressed "T" waves, and aberration of the ventricular complexes.

The treatment of the beriberi patients with heart failure consists of bed rest and a diet rich in vitamin B₁ and adequate amounts of complete proteins. The latter element is important for the edema is invariably due in part to hypoproteinemia. Relief is prompt and complete. Little or no effect is gained by the additional use of digitalis and diuretics.

The frequency of sub-clinical degrees of B₁ avitaminosis in chronic heart disease is difficult to estimate yet it is probably a factor of greater clinical importance than is generally appreciated.

Rhachitis (rickets) is concerned primarily with

a deficiency of vitamin D. Children dying of this disease show at necropsy cardiac dilatation predominantly of the left ventricle. From a clinical standpoint the cardiac complications are not of great importance, for in most civilized communities the condition is corrected by diet and sunshine before cardiac complications have become clinically significant. Indirectly vitamin D deficiencies are important, for children with rhachitis are very susceptible to upper respiratory infections which in turn tend to activate latent rheumatic fever.

Scorbutus (scurvy), vitamin C deficiency, does not affect the heart to a degree clinically significant. The pathologic lesions involve primarily the arterioles and capillaries with a marked tendency toward hemorrhages which may involve the epicardium and pericardium. Degeneration of the myocardium has been found in fatal cases of scurvy.

Recent experimental observations appear to indicate that lesions quite similar to those found in rheumatic fever can be produced in animals suffering from subacute scurvy when they are subjected to parenteral injections of streptococci. It is possible that vitamin C is an important element in the defensive mechanisms of the animal for the nature of the reaction to infection in animals can be definitely modified by vitamin C.

Pellagra is concerned probably with a deficiency of B₃ or G and, although it is a common malady, no specific cardiac pathology has been found to be associated with it. In a recent study of twenty pellagrins it was found that the hearts were of the asthenic type; there was a moderate degree of sinus tachycardia even after the clinical symptoms had disappeared, and the electrocardiograms taken bi-weekly during the duration of clinical symptoms were without exception normal. Hypertension was not noted in any of the patients. The impression gained from this study is that pellagrins have a hypoplastic cardiovascular apparatus which is not due to the disease but is a constitutional characteristic of those in whom it develops.

B. There is much data on the bio-chemistry of muscle physiology which is immediately concerned with the function of the myocardium and conversely with development of heart failure. The physiologic integrity of the heart muscle is dependent upon glucose, insulin, and oxygen, and there exists an obligatory interdependency between these elements.

Briefly stated these data are: an adequate supply of oxygen must be available at all times since the conversion of glucose to glycogen in the heart muscle is dependent not only on insulin but also upon a free oxygen supply. The energy for muscle contraction comes from the breaking down of phosphagen but the energy for the resynthesizing of phosphagen is derived from the breaking down of glycogen to lactic acid. The lactic acid is reconverted into glucose and the glucose under the influence of oxygen and insulin reconverted into glycogen. Thus continued heart muscle contraction may be interrupted by lack of phosphagen, or depletion of muscle glycogen, and these deficiencies in

turn result from failure in adequate supply of oxygen and insulin. These inter-related bio-chemical mechanisms are particularly liable to be upset in thyrotoxicosis, diabetes, and heart failure.

Thyrotoxicosis: It is a well known clinical observation that thyrotoxicosis has a profound influence upon the heart. It is important to note that animals intoxicated by thyroxin are far more sensitive to the withdrawal of oxygen than is the normal animal, and there is in them a marked reduction of heart muscle glycogen. These data are important in the therapeutic control of post-operative and spontaneous hyperthyroid crises, particularly in the patients with a diminished coronary blood flow.

Diabetes: There is increasing evidence indicating that coronary disease is frequent and occurs prematurely in diabetes. With reduction of the effective supply of insulin and oxygen, there results reduction of glycogen synthesis which in turn will reflect itself clinically in reduction of myocardial reserve. On the other hand it has been shown experimentally that with reduction in coronary blood flow it is obligatory that the concentration of glucose in the blood be raised if a normal muscle glycogen is to be maintained. It is apparent therefore that it is not prudent to reduce the blood sugar to the theoretical normal (100 mg. per 100 cc.) in the diabetic in whom arteriosclerotic heart disease may be reasonably supposed to exist lest a deficiency occur in the heart muscle glycogen.

Edema from Protein Deficiency: Any discussion of the heart in deficiency diseases would be incomplete if it did not include a brief consideration of the plasma proteins and their relation to edema. It is commonly accepted that the reduction of the plasma proteins is the essential factor concerned in the mechanism of nephrotic edema. It is only recently that there has been a full appreciation of the importance of such a mechanism which, co-existent with increased filtration pressure, operates frequently in chronic congestive heart failure in the production of edema. Because of the use of diets unnecessarily restricted in complete proteins and protein loss in the urine and edema fluid, a moderate or marked reduction of the plasma proteins—particularly the important albumin fraction—is often present in congestive heart failure. The resulting reduction of effective osmotic pressure of the blood associated with elevated venous pressure induces a greater amount of edema, and if the plasma deficiency is not corrected edema may remain fixed though digitalis has been efficiently used.

The importance of an adequately balanced diet in heart disease with congestive failure, cannot be too strongly emphasized, particularly if the individual affected is under weight. The protein intake must be sufficient to maintain nitrogen balance, the total calories adequate, and, if there is a reduction of plasma proteins, the diet must include at least two grams of complete protein per kilo of normal body weight.

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